

CRITERION 507
LIGHTNING PROTECTION SYSTEMS

SIGNATURES

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RECORD OF REVISIONS

Revision No.	Date	Description
0	08/27/98	Initial Issue. Replaces 3.7-600, Rev. 0. Deleted Forward, Statement of Authority, Maintenance Standard Update, 1.0 General Requirements and 2.0 LANL Maintenance Policy Documents.
1	04/01/02	This revision includes the addition of a Table of Contents, the use of Basis Statements in Sections 6 and 7, and incorporates a review of ORPS & NRC lessons learned 1/1/95 to 6/2000.
	04/16/02	This revision incorporates the latest format of the Criterion 101: Writer's Guide Revision 3.
	4/17/02	Inclusion of comments and changes from Maintenance Subcommittee review.
	5/22/02	Rewording of Requirement Training Section 6.2 and inclusion of AHJ per Maintenance Committee request.
	5/31/02	Inclusion of comments and changes from Maintenance Subcommittee
	7/16/02	Change in Definitions
2	7/21/03	Addition of Requirements for structures with Faraday Cage or Faraday-like Shield in explosive areas (Section 6.3) Incorporation of all resolved comments from PEER and POC/FM reviews.
3	10/01/05	Added Operability and Impairment Definitions. Added requirement for Operability Determinations
4	4/1/06	Added several definitions; reorganized requirements in Sections 6 and 7; revised Appendix A to remove ML levels; incorporated a review of Lessons Learned from 6/2000 to 3/2006
5	6/6/06	Added UL certification as acceptable to demonstrate competence as a LPS inspector

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CRITERION 507

LIGHTNING PROTECTION SYSTEMS

1.0 PURPOSE

This Criterion establishes the minimum requirements and best practices for operation, inspection, and maintenance of lightning protection systems at LANL. This document addresses the requirements of LIR 230-05-01 (Ref. 10.4), "Operations and Maintenance Manual."

Implementation of this Criterion satisfies DOE Order 430.1B (Ref. 10.2) for the subject equipment / systems – DOE Order 430.1B (Ref. 10.2), "Real Property Asset Management," Attachment 2 "Contractor Requirements Document," Paragraph 3, which in part requires UC to "to balance acquisition, sustainment, recapitalization and disposal to ensure that real property assets are available, utilized, and in a suitable condition to accomplish DOE's missions; and Attachment 3 "Definitions": Maintenance. Day to day work that is required to sustain property in a condition suitable for it to be used for its designated purposes, including preventive, predictive, and corrective maintenance.

2.0 SCOPE

This document covers the inspecting, testing, and maintaining of all lightning protection systems at scheduled intervals, in accordance with ANSI/NFPA 780 (Ref. 10.8) and DOE M440.1-1 (Ref. 10.3). This Criterion does not address corrective maintenance actions required to repair or replace equipment.

3.0 ACRONYMS AND DEFINITIONS

3.1 ACRONYMS

AHJ	Authority Having Jurisdiction
ANSI	American National Standards Institute
CFR	Code of Federal Regulations
DOE	Department of Energy
LANL	Los Alamos National Laboratory
LIR	Laboratory Implementing Requirement
LPI	Lightning Protection Institute
LPR	Laboratory Performance Requirement

NFPA	National Fire Protection Association
O&M	Operations and Maintenance
PMI	Preventive Maintenance Instruction
PP&PE	Personal Property and Programmatic Equipment
RP&IE	Real Property and Installed Equipment
SME	Subject Matter Expert
SSC	Structures, Systems, and Components
SSS	Support Services Subcontractor
UC	University of California
UL	Underwriters Laboratory

3.2 DEFINITIONS

Air Terminal. That component of a lightning protection system that is intended to intercept lightning flashes; lightning rod.

Approved. Acceptable to the authority having jurisdiction.

Authority Having Jurisdiction (AHJ). An organization, office, or individual responsible for enforcing the requirements of a code or standard, or for approving equipment, materials, an installation, or a procedure.

Bonding. An electrical connection between an electrically conductive object and a component of a lightning protection system that is intended to significantly reduce potential differences produced by lightning currents.

Catenary Lightning Protection System. A lightning protection system consisting of overhead wire suspended from poles connected to a grounding system via down conductors.

Explosives Facilities. A structure or defined area used for explosives storage or operation as defined by the DOE Explosives Safety Manual

“Faraday Cage or Faraday Like Shield”. An LPS where the area to be protected is enclosed by a heavy metal screen, like a bird cage; or continuous metallic structure with no un-bonded metallic penetrations.

Fastener. An attachment device used to secure the conductor to the structure.

Ground Terminal. That component of a lightning protection system such as a ground rod or a counterpoise conductor that is intended to provide electrical contact with the earth.

Impaired. System deviates from applicable codes and standards however is still able to perform its intended function.

Inoperable. System deviates from applicable codes and standards and is not able to perform its intended function

Lightning Protection System (LPS). A complete system of strike termination devices, conductors, ground terminals, interconnecting conductors, surge suppression devices, and other connectors or fittings required to complete the system.

Listed. Equipment, materials, or services included in a list published by an organization that is acceptable to the authority having jurisdiction and concerned with evaluation of products or services, that maintains periodic inspection of production of listed equipment or materials or periodic evaluation of services, and whose listing states that either the equipment, material, or service meets appropriate designated standards or has been tested and found suitable for a specified purpose.

Shall. Indicates a mandatory requirement.

Should. Indicates a recommendation or that which is advised but not required.

Operable System is in accordance with applicable codes and standards and is able to perform its intended function

Strike Termination Device. A component of a lightning protection system that intercepts lightning flashes and connects them to a path to ground. Strike termination devices include air terminals, metal masts, permanent metal parts of structures, and overhead ground wires installed in catenary lightning protection systems.

Subject Matter Expert (SME). The person with the knowledge and ability to guide Laboratory and DOE personnel in the area of lightning protection as delegated by the LANL Fire Marshal.

Surge. A transient wave of current, potential, or power in an electric circuit. Surges do not include longer duration temporary overvoltages (TOV) consisting of an increase in the power frequency voltage for several cycles.

Surge Arrester. A protective device for limiting surge voltage by discharging or bypassing surge currents. It also prevents continued flow of follow current while remaining capable of repeating these functions. Surge arresters are installed on electrical service entrances, antenna cables, telephone service entrance, and other wire service entrance (fire alarm and security).

Transfer Impedance. A transmittance expressed as a ratio of the electric field on the interior of a shielded enclosure divided by the current density on the exterior of the shield.

4.0 RESPONSIBILITIES

4.1 FM - MAINTENANCE SUPPORT AND ENGINEERING (MSE)

4.1.1 FM-MSE is responsible for the technical content of this Criterion.

4.1.2 FM-MSE shall provide technical assistance to support implementation of this Criterion.

4.1.3 FM-MSE shall perform an Operability Determination for lightning protection systems inspected by MSE personnel. Operability determinations for inspections performed by others may be conducted by MSE personnel, as requested.

4.2 MAINTENANCE MANAGER

4.2.1 Responsible for maintenance of institutional, or Real Property and Installed Equipment (RP&IE) under their jurisdiction, in accordance with the requirements of this document.

4.2.2 Responsible for maintenance of those Personal Property and Programmatic Equipment (PP&PE) systems and equipment addressed by this document that may be assigned to the FM in accordance with the FMU-specific Facility/Tenant Agreement.

4.3 MSE GROUP LEADER

4.3.1 Responsible for maintenance of those Personal Property and Programmatic Equipment (PP&PE) systems and equipment addressed by this document, which are under their jurisdiction.

4.3.2 Responsible for program performance analysis.

4.4 AUTHORITY HAVING JURISDICTION (AHJ) – FIRE MARSHAL

4.4.1 The AHJ is the final authority on the need for lightning protection systems at Laboratory facilities.

4.5 SUBJECT MATTER EXPERT (SME)

The SME is responsible for technical interpretation of LPS design issues and utilization at the Laboratory.

4.6 LIGHTNING PROTECTION SYSTEM INSPECTORS

4.6.1 Responsible for maintaining certification from a recognized lightning protection system inspection agency.

4.6.2 Responsible to perform LPS inspections and testing per accepted practices.

4.7 FIRE PROTECTION ENGINEER

4.7.1 Responsible for performing Operability Determinations of lightning protection systems in accordance with this O&M.

- 4.7.2 Responsible to notify facility personal when lightning protection systems are determined to be other than Operable.

5.0 PRECAUTIONS AND LIMITATIONS

5.1 PRECAUTIONS

This section is not intended to identify all applicable precautions necessary for implementation of this Criterion. A compilation of all applicable precautions shall be contained in the implementing procedure(s) or work control authorization documents. The following precautions are intended only to assist the author of a procedure or work control document in the identification of hazards/precautions that may not be immediately obvious.

- 5.1.1 Follow the safety precautions listed in NFPA 780, Annex M, when inspecting, testing, or maintaining lightning protection systems. Provide for fall protection as outlined in LIR 402-10-01.8 Hazard Analysis and Control for Facility Work (Ref. 10.9)

- 5.1.2 Aerial lifts or similar devices shall conform to 29CFR 1910.67.

5.2 LIMITATIONS

The intent of this Criterion is to identify the minimum generic requirements and recommendations for SSC operation and maintenance across the Laboratory. Each user is responsible for the identification and implementation of additional facility specific requirements and recommendations based on their authorization basis and unique equipment and conditions, (e.g., equipment history, manufacturer warranties, operating environment, vendor O&M requirements and guidance, etc.).

Nuclear facilities and moderate to high hazard non-nuclear facilities will typically have additional facility-specific requirements beyond those presented in this Criterion. Nuclear facilities shall implement the requirements of DOE Order 431.1 (Ref. 10.1) as the minimum programmatic requirements for a maintenance program. Additional requirements and recommendations for SSC operation and maintenance may be necessary to fully comply with the current DOE Order identified above.

This Criteria does not specify inspection test and maintenance requirements for lightning detection and notification systems used a substitute for Inoperable or Impaired lightning protection systems.

6.0 REQUIREMENTS

Minimum requirements that Criterion users shall follow are specified in this section. The Criterion users are responsible for analysis of operational performance and SSC replacement or refurbishment based on this section. Laws, codes, contractual requirements, engineering judgment, safety matters, and operations and maintenance experience drive the requirements contained in this section.

6.1 OPERATIONS REQUIREMENTS

No operations requirements. Lightning protection systems are designed to be passive systems that are maintained in a state of readiness through a program of inspection testing and repair.

6.2 MAINTENANCE REQUIREMENTS

6.2.1 Personnel Qualifications - Lightning Protection System Inspector

Personnel responsible for maintenance, inspection and testing of lightning protection systems for explosive facilities must be knowledgeable of and properly trained in the fundamentals described in NFPA 780 and DOE M440.1-1 (Explosives Safety Manual)

Basis: DOE M440.1-1, Chapter X, Section 3, Inspection and Testing of Lightning Protection System (Ref. 10.3)

Note: LPS inspectors and installer qualification may be demonstrated by certification by the Lightning Protection Institute (LPI), Underwriters Laboratory (UL), or by documented evaluation by the LPS SME and AHJ.

6.2.2 Personnel Qualification – Evaluator, Operability Determinations

Personnel responsible for performing operability evaluations of lightning protection systems shall be qualified as a Fire Protection Engineer per DOE criteria and be knowledgeable in operation of lightning protection systems, or be recognized as an LPS SME by the AHJ.

Basis: DOE 420.1B, Facility Safety, Chapter 2 (Ref. 10.10)

6.2.3 Lightning Protection System Inspections

LPS inspections shall be performed as follows:

6.2.3.1 All Facilities

- Lightning protection system shall be inspected whenever any alterations or repairs are made. Record modifications to lightning protection systems in the record drawings and other pertinent documents.

Basis: NFPA 780, B-1.1.1. (Ref. 10.8)

- A lightning protection system should be inspected following any known lightning discharge to the system.

Basis: NFPA 780, B-1.1.1. (Ref. 10.8)

6.2.3.2 Explosives Facilities

- Develop procedures and execute a program for lightning protection system maintenance according to the requirements of NFPA 780 and the minimum requirements of this document.

Basis: DOE M 440.1-1, Chapter X, Section 3.0 b.1. (Ref. 10.3)

- Visual inspection of lightning protection systems should be conducted every seven months and shall be conducted at least annually.
Basis: DOE M 440.1-1, Chapter X, Section 3.0 b.1. (Ref. 10.3)
- Electrical testing for lightning protection systems should be conducted every 14 months and shall be conducted at least every forty-seven (47) months.
Basis: DOE M 440.1-1, Chapter X, Section 3.0 d. (Ref. 10.3)

6.2.3.3 Conventional Facilities

For structures not subjected to DOE M440.1-1 (Ref. 10.3) it is recommended that lightning protection systems be visually inspected at least annually. Complete in-depth inspections of all systems should be completed every three to five years.

Basis: NFPA 780, B-1.1.2. (Ref. 10.8)

Basis: DOE M 440.1-1, (see paragraph 6.2.1.1, 6.2.1.2). (Ref. 10.3)

6.2.3.4 Structures with Faraday Cage or Faraday-Like Shield Lightning Protection System

- Bonds and surge suppressors shall be visually inspected every two years to validate the installation and serviceability.
Basis: DOE M440.1-1, Chapter X, Section 3.0 a (Ref. 10.3)
- A visual inspection shall be performed on surge suppression devices and other LPS components after all lightning flash events where there are visible indications on the structure of a lightning strike and any time there is modification, maintenance or repair to the structure, or penetration that could affect the SSD. or LPS component.
Basis: DOE M440.1-1, Chapter X, Section 3.0 b (Ref. 10.3)
- Electrical resistance measurements of visible bonds shall be taken every five years. Such measurements are also required when there are visible indications on the structure that an act of nature such as an earthquake, tornado, flood, etc. or other act could have affected the integrity of the bonds; and any time modification, maintenance or repair to the structure, penetration of LPS components require the bond or connection to be broken.
Basis: DOE M440.1-1, Chapter X, Section 3.0 c (Ref. 10.3)
- Bond resistance shall be less than 1.00 ohm. A 1.5 ohm resistance is acceptable where necessary for joining of existing structural elements by rebar bonding.
Basis: DOE M 440.1-1, Chapter X, Section 3.0 c.2 (Ref. 10.3)
- Tighten to manufacturer recommended torque or replace bonds which do not meet the resistance requirement of 6.3.3.1.
Basis: DOE M 440.1-1, Chapter X, Section 3.0 c.2 (Ref. 10.3)
- Transfer impedance measurements shall be taken every fifteen years. Such measurements are also required when there are visible indications on the structure that an act of nature such as an earthquake, tornado, flood, etc. or other act could

affect the integrity of the internal structure bonds; and any time there is major modification, maintenance or repair to the structure.

Basis: DOE M440.1-1, Chapter X, paragraph 3.0 (x) (Ref. 10.3)

6.2.4 LPS Operability Determination

Lightning Protection System (LPS) OPERABILITY is based on the material condition of the system coupled with an operability assessment for those systems whose condition is not per Code requirements. Systems may be “Operable”, “Impaired”, or “Inoperable depending on the as-found condition of the installation.

The LPS OPERABILITY determination is made as follows:

6.2.4.1 An operability assessment will be performed to assess the severity of all deficiencies. The assessment will determine if the system is impaired or inoperable. Facility management, including the RDL and facility manager, will be informed of the operability status of the lightning protection system upon completion of the assessment and shall take appropriate actions.

6.2.4.2 The LPS operability status is entered into the Fire Protection System Impairment database in accordance with Criterion 733: *Fire Protection System Impairment Control Program*. (Ref.10.11)

Note: An impairment would reflect a LPS that had deficiencies that are not expected to render the system ineffective. Examples include:

- Detached fasteners that do not cause the conductors to sag or otherwise come into contact with building component that are conducting (other than parts of the LPS itself),
- A loose connection, provided that a second path to ground exists (except connection to an air terminal),
- A single air terminal deficient in a line of three.

6.2.5 Program Assessment

Programmatically, the status of the LPS Program will be assessed via reports along with the existing Fire Protection Program impairments.

The LPS program is demonstrated to be in good health, i.e., "Green", if less than 5 % of all required buildings' LPS are impaired or inoperable. This corresponds to 10 building LPS's. (Approximately 200 buildings are classified as “Explosive” or “Nuclear”). A marginal or "Yellow" grade should be used for an impairment/inoperable rate of < 10% or 20 buildings' LPS's impaired or inoperable. A higher level of impairment or inoperability system results in a deficient, or “Red” LPS program condition.

7.0 RECOMMENDATIONS AND GOOD PRACTICES

The information provided in this section is recommended based on acceptable industry practices, codes and standards, manufacturers recommendations, operating experience, DOE/LANL Lessons Learned program or engineering judgement and should be implemented by each user based on his/her unique application and operating history of the subject systems/equipment.

Appendix A to this document contains recommended lightning protection system inspection and testing schedules.

Appendix B to this document contains recommended lightning protection system maintenance items to be addressed.

7.1 OPERATIONS RECOMMENDATION

None

7.2 MAINTENANCE RECOMMENDATIONS

7.2.1 Maintenance and Operational Testing Logs

Record routine inspections and tests using logs for each lightning protection system.

Basis: NFPA 780, B-1.5. (Ref. 10.8)

7.2.2 Maintenance and Testing Procedures

Prepare specific maintenance and testing procedures and other work-related documents (e.g., lightning protection system drawings) for each maintenance category. Use inspection and test procedures to provide appropriate work directions and to ensure that maintenance is done safely, efficiently, and according to this maintenance document. LPI documents may be used as a guide.

Basis: NFPA 780, B-1.5. (Ref. 10.8)

8.0 GUIDANCE

8.1 MAINTENANCE GUIDANCE

Appendix B of NFPA 780 (Ref. 10.8) provides the following guidance for inspecting and maintaining lightning protection systems:

B.1 Inspection of Lightning Protection Systems.

B.1.1 Frequency of Inspections It is understood that all new lightning protection systems must be inspected following completion of their installation. However, it is also very important to make periodic inspections of existing systems. The interval between inspections should be determined by such factors as the following:

- (0) Classification of structure or area protected

- (2) Level of protection afforded by the system
- (3) Immediate environment (corrosive atmospheres)
- (4) Materials from which components are made
- (5) Type of surface to which the lightning protection components are attached
- (6) Trouble reports or complaints

B.1.1.1 In addition to regular periodic inspections, a lightning protection system should be inspected whenever any alterations or repairs are made to a protected structure, as well as following any known lightning discharge to the system.

B.1.1.2 It is recommended that lightning protection systems be visually inspected at least annually. In some areas where severe climatic changes occur, it may be advisable to visually inspect systems semiannually or following extreme changes in ambient temperatures. Complete, in-depth inspections of all systems should be completed every three to five years. It is recommended that critical systems be inspected every one to three years depending on occupancy or the environment where the protected structure is located.

B.1.1.3 In most geographical areas, and especially in areas that experience extreme seasonal changes in temperature and rainfall, it is advisable to stagger inspections so that earth resistance measurements, for example, are made in the hot, dry months as well as the cool, wet months. Such staggering of inspections and testing is important in assessing the effectiveness of the lightning protection system during the various seasons throughout the year.

B.1.2 Visual Inspection. Visual inspections are made to ascertain the following:

- (1) The system is in good repair.
- (2) There are no loose connections that might result in high resistance joints.
- (3) No part of the system has been weakened by corrosion or vibration.
- (4) All down conductors and ground terminals are intact (nonsevered).
- (5) All conductors and system components are fastened securely to their mounting surfaces and are protected against accidental mechanical displacement as required.
- (6) There have not been additions or alterations to the protected structure that would require additional protection.
- (7) There has been no visual indication of damage to surge suppression (overvoltage) devices.
- (8) The system complies in all respects with the current edition of this standard.

B.1.3 Complete Testing and Inspection. Complete testing and inspection includes the visual inspections described in B.1.2 and the following:

- () Tests to verify continuity of those parts of the system that were concealed (built in) during the initial installation and that are not now available for visual inspection.
- () Ground resistance tests of the ground termination system and its individual ground

electrodes if adequate disconnecting means have been provided. These test results should be compared with previous or original results or current accepted values, or both, for the soil conditions involved. If it is found that the test values differ substantially from previous values obtained under the same test procedures, additional investigations should be made to determine the reason for the difference.

- () Continuity tests to determine if suitable equipotential bonding has been established for any new services or constructions that have been added to the interior of the structure since the last inspection.

B.I.4 Inspection Guides and Records. Inspection guides or forms should be prepared and made available to the authority responsible for conducting inspections of lightning protection systems. These guides should contain sufficient information to guide the inspector through the inspection process so that he or she may document all areas of importance relating to the methods of installation, the type and condition of system components, test methods, and the proper recording of the test data obtained.

B.1.5 Records and Test Data. The inspector or inspection authority should compile and maintain records pertaining to the following:

- (0) General condition of air terminals, conductors, and other components
- (0) General condition of corrosion-protection measures
- (0) Security of attachment of conductors and components
- (0) Resistance measurements of various parts of the ground terminal system
- (0) Transfer impedance measurements at all required points (These records are required DOE M 440.1-1, Chapter 10, 3.0e.1.)
- (0) Any variations from the requirements contained in this standard
- (0) A diagram of the structure or room showing all points requiring measurements or visual inspection and location of surge suppressors (This is recommended by DOE M 440.1-1, 3.0.e.2.)

B.2 Maintenance of Lightning Protection Systems.

B.2.1 General. Maintenance of a lightning protection system is extremely important even though the lightning-protection design engineer has taken special precautions to provide corrosion protection, and has sized the components according to their particular exposure to lightning damage. Many system components tend to lose their effectiveness over the years because of corrosion factors, weather-related damage, and stroke damage. The physical as well as the electrical characteristics of the lightning protection system must be maintained in order to maintain compliance with design requirements.

B.2.2 Maintenance Procedures.

B.2.2.1 Periodic maintenance programs should be established for all lightning protection systems. The frequency of maintenance procedures is dependent on the following:

- (0) Weather-related degradation
- (0) Frequency of stroke damage
- (0) Protection level required
- (0) Exposure to stroke damage

B.2.2.2 Lightning protection system maintenance procedures should be established for each system and should become a part of the overall maintenance program for the structure that it protects.

A maintenance program should contain a list of more or less routine items that can serve as a checklist and establish a definite maintenance procedure that can be followed regularly. It is the repeatability of the procedures that enhance the effectiveness of a good maintenance program.

A good maintenance program should contain provisions for the following:

- (0) Inspection of all conductors and system components
- (0) Tightening of all clamps and splicers
- (0) Measurement of lightning protection system resistance
- (0) Measurement of resistance of ground terminals
- (0) Inspection or testing, or both, of surge suppression devices to determine their effectiveness compared with similar new devices
- (0) Refastening and tightening of components and conductors as required
- (0) Inspection and testing as required to determine if the effectiveness of the lightning protection system has been altered due to additions to, or changes in, the structure

B.2.3 Maintenance Records. Complete records should be kept of all maintenance procedures and routines and should include corrective actions that have been or will be taken. Such records provide a means of evaluating system components and their installation. They also serve as a basis for reviewing maintenance procedures as well as updating preventive maintenance programs.

9.0 REQUIRED DOCUMENTATION

Maintenance history shall be maintained to include, as a minimum, the parameters listed in the Table 9-1 below:

Table 9-1 Documentation Parameters

MAINTENANCE HISTORY DOCUMENTATION PARAMETERS				
PARAMETER	ML 1	ML 2	ML 3	ML 4
Maintenance Activities				
Repair / Installation	X	X	X	X
PM Activities	X	X	X	X
Inspection Records				
Inspection Date	X	X	X	X
SSC Condition	X	X	X	X
General conditions of air terminals, conductors and other components	X	X	X	X
General conditions of corrosion-protection measures	X	X	X	X
Security of attachments of conductors and components	X	X	X	X
Resistance measurements of various parts of the ground terminal system	X	X	X	X
Any variations from the requirements contained in NFPA 780 or LANL Criterion 507	X	X	X	X
Condition of surge arresters	X	X	X	X
Electrical Test Records				
Electrical continuity of concealed components	X	X	X	X
Resistance between strategic points of the system	X	X	X	X
Ground resistance of ground terminals	X	X	X	X
Transfer Impedance Measurements for Faraday Cages	X	X	X	X

Basis: Documentation of the parameters listed in Table 9-1 above satisfies the requirements of LPR 230-07-00, Criteria 2, (Ref. 10.5) which states; "Maintenance activities, equipment problems, and inspection and test results are documented". For ML definitions, see LIR 230-01-02.2.(Ref. 10.12)

10.0 REFERENCES

- 9.0 DOE Order 433.1, Maintenance Management Program for DOE Nuclear Facilities
- 9.0 DOE O 430.1B, Attachments 2 “Contractor Requirements Document” & 3 “Definitions”
- 9.0 DOE M 440.1-1 Explosives Safety Manual, Chapter 10, Section 3.0
- 9.0 LIR 230-05-01.0, Operation and Maintenance Manual.
- 9.0 LPR 230-07-00, Maintenance History
- 9.0 LANL- Facility Construction Manual 16670
- 9.0 LANL ID No.00-033, LANL-LAAO/CPAP-00-01-LP-01, DOE/AL Annual ES&H Review
- 9.0 NFPA 780, Lightning Protection Code
- 9.0 LIR 402-10-01.8 Hazard Analysis and Control for Facility Work
- 9.0 DOE 420.1B, Facility Safety
- 9.0 O&M Criterion 733: Fire Protection System Impairment Control Program.
- 9.0 LIR 230-01-02.2 Graded Approach to Facility Work

11.0 APPENDICES

Appendix A: Lightning Protection System Maintenance Schedule

Appendix B: Lightning Protection System Recommended Maintenance Items

APPENDIX A

LIGHTING PROTECTION SYSTEM MAINTENANCE SCHEDULE

Parameter	Facilities used for storage, processing, and handling of explosive materials.	Non-Explosive Structures
REF.	DOE M-440.1-1	NFPA 780 B-1.1.2
Visual Inspections	Should be conducted every seven months and shall be conducted at least annually	Recommended at least annually
Electrical Testing (earth resistance)	Should be conducted every 14 months and shall be conducted at least every 47 months.	Complete in-depth inspections of all systems should be completed every three to five years. It is recommended that critical systems be inspected every one to three years.

APPENDIX B

LIGHTING PROTECTION SYSTEM RECOMMENDED MAINTENANCE ITEMS

ITEM No.	ACTIVITY
1	Inspect air terminals.
2	Inspect bonds to metal bodies.
3	Inspect tee-splicers and other connectors.
4	Inspect through roof connectors.
5	Inspect cable holders.
6	Inspect down conductors and grounds.
7	Check for additions or alterations to structure.
8	Measure ground terminal resistance.
9	Test continuity of concealed parts.
10	Measure system resistance
11	Inspect surge arresters.